Research Article

Cardiovascular disease risk in individuals with chronic spinal cord injury: Prevalence of untreated risk factors and poor adherence to treatment guidelines

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Background/Objective: Cardiovascular disease (CVD) is currently the leading cause of mortality among individuals living with chronic spinal cord injury (SCI). The purpose of this study is to: 1) Describe the prevalence of CVD risk factors including dyslipidemia (DYS), hypertension (HTN) and type II diabetes mellitus (DM) in patients with chronic SCI; 2) Report the frequency of individuals recommended for diagnostic testing, as per current Canadian CVD diagnostic guidelines; and 3) Report the frequency of individuals receiving guideline-derived appropriate therapy for these risk factors.

Methods: Adults with a chronic, stable SCI (n = 91) were included in this study. Medical histories, current medications, blood serum analyses and blood pressures were collected and compared to current Canadian CVD diagnostic guidelines to assess for DYS, HTN and DM.

Results: Of the 81 participants with blood serum analyses, 10 (14.7%) of 23 (28.4%) individuals meeting diagnostic criteria for DYS were not taking appropriate statin medication and 2 (2.5%) of 7 (8.6%) individuals meeting diagnostic criteria for DM were not taking appropriate DM medication. Of the 91 participants having BP measurements, 13 (14.3%) of 26 (28.6%) individuals meeting diagnostic criteria for HTN were not taking appropriate BP medication.

Conclusions: In addition to a high prevalence of CVD risk factors among individuals with chronic SCI, there is also evidence of poor adherence to diagnostic and treatment guidelines for DYS, HTN and DM. The study results highlight an important gap between the observed prevalence of disease and the low rates of screening and guideline adherence in the SCI population.

Keywords: Cardiovascular disease, Diabetes mellitus, Dyslipidemia, Hypertension, Spinal cord injury

Background

Cardiovascular disease (CVD) is currently the leading cause of mortality amongst individuals living with chronic spinal cord injury (SCI)[1–3] contributing to ~46% of all deaths in individuals greater than 30 years post-injury, and ~35% of deaths in individuals with SCI over the age of sixty. Prevention of CVD through risk factor identification, management and amelioration is a priority health concern for this patient population.[4] Despite a plethora of evidence-informed guidelines for the detection and management of CVD risk in the general population,[5] there are few evidence-informed guidelines in place that are specifically tailored to the SCI population.

Previous cross-sectional studies have shown that the prevalence of multiple risk factors is higher in individuals with SCI when compared to the general population.[6–8] These risk factors include, but are not limited to, an increased prevalence of: central obesity;[9] dyslipidemia with lowered high-density lipoprotein cholesterol (HDL-C) levels; elevated total cholesterol (TC) to HDL-C ratios;[10,11] type II diabetes mellitus;[12,13] elevated C-reactive protein (CRP);[4] and an increased

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incidence of hypertension in individuals with paraplegia.[14] While it is well established that the SCI population has a high prevalence of a number of CVD risk factors, there is a paucity of studies that correlate the prevalence of these risk factors with implementation of management protocols or evidence-informed treatment guidelines, contrary to the abundance of these tools for the general population.[15] This includes examining whether individuals with SCI who meet guideline-specific risk thresholds subsequently receive further diagnostic testing or appropriate treatment.[16–18] While it is important to uncover the prevalence of specific risk factors contributing to CVD, it is also vital that we ensure the proper screening protocols are in place, that treatment for established risk factors is administered according to current guidelines, and that therapeutic re-evaluation is done in a timely manner.

The purpose of this study is to: (1) describe the prevalence of CVD risk factors including dyslipidemia (DYS), hypertension (HTN) and type II diabetes mellitus (DM) in a cohort of patients with chronic SCI, as defined by current Canadian CVD diagnostic guidelines; (2) report the frequency of individuals recommended for further diagnostic testing; (3) report the frequency of individuals receiving guideline-derived appropriate therapy for these risk factors; and (4) highlight the gap between current evidence and the number of individuals receiving inappropriate or inadequate therapy.

Methods

Study design and population

This was a single center cross-sectional study conducted at a tertiary SCI rehabilitation hospital in Toronto, Canada (Lyndhurst Centre, Toronto Rehabilitation Institute-University Health Network) under the approval of the University Health Network Research Ethics Board. One hundred and twenty-five English-speaking adults (≥18 and <80 years of age) with a chronic (≥2 years post-injury), stable spinal cord impairment (C1–T10 AIS A–D), with diverse non-traumatic or traumatic etiologies for SCI, were screened for study inclusion. Individuals with a prior or current history of angina, myocardial infarction, atypical chest pain, coronary heart bypass or prior revascularization, aortic stenosis, uncontrolled arrhythmia or left bundle branch block, hypertrophic cardiomyopathy, severe chronic pulmonary disease requiring oral steroids or home oxygen, diaphragmatic pacer or prior stroke, were excluded. Of the 125 participants screened, 91 met inclusion and underwent evaluation for CVD risk factors.

Data collection

Medical history, current medications and height were collected through interview and chart abstraction from medical records. Bedside and serum assessments were done in a morning, fasting, supine state. Brachial blood pressure (BP) was measured using a mercury sphygmomanometer while participants were supine on the examination plinth. Two consecutive measurements of systolic blood pressure (SBP) and diastolic blood pressure (DBP) were completed at least one minute apart, followed by a repeat of these two measurements after conducting diagnostic testing procedures. The mean of these four BP and heart rate (HR) values for both SBP and DBP were calculated for each participant (n = 91). Fasting serum blood analyses were obtained (12 hours after eating) from participants by local laboratories, including collection of fasting plasma blood glucose (FPG), total cholesterol (TC), high-density lipoproteins cholesterol (HDL-C), low-density lipoproteins cholesterol (LDL-C), triglycerides (TG) and glycated hemoglobin (A1C). Non-HDL cholesterol values were calculated by subtracting HDL-C values from the total cholesterol (TC) values. The aforementioned serum samples were obtained from 81 of the 91 participants, with some participants missing serum collection due to time and transportation constraints. The prevalence and therapy status of DYS, HTN and DM were reported for this population.

Diagnosis recommendations

Dyslipidemia (DYS)

Current Canadian guidelines were used in order to determine if participants who met diagnostic thresholds should have been recommended for further testing or should have begun therapy for DYS, HTN and/or DM.[16–18] Looking first at DYS, participants were categorized into risk groups according to the Canadian Cardiovascular Society (CCS) Dyslipidemia Guidelines from 2013.[16] These guidelines recommend that both the Framingham risk score and LDL cholesterol levels be used during assessment for DYS. The participants were categorized into three risk groups—individuals with a Framingham score <10% were considered the "Low Risk" (LR) group, 10–19% were the "Intermediate Risk" (IR) group and ≥20% were the "High Risk" (HR) group. Within these groups, LDL levels were used to determine whether statin therapy was recommended. From the "Low Risk" LR group, only individuals with LDL ≥5 mmol/L (193 mg/dL), were recommended for statin therapy. From the IR group, individuals with LDL ≥3.5 mmol/L (135 mg/dL) were recommended for initiation of statin therapy, and in addition, any

individuals in the LDL <3.5 mmol/L (135 mg/dL) subgroup with non-HDL levels ≥4.3 mmol/L (166 mg/dL) were also recommended for statin therapy. For the HR group, all individuals were recommended to receive statin therapy, regardless of their LDL levels.

Type II diabetes mellitus (DM)

For diagnosis of DM, the Canadian Journal of Diabetes (CJD) guidelines published in 2013 recommended that individuals be screened for DM by examining fasting blood glucose (FBG) and/or glycated hemoglobin levels (A1C).[17] These values can then be used to determine if individuals are at a "Low Risk" (LR) for DM, if they are recommended to have a 75 g oral glucose tolerance test (OGTT) to provide additional diagnostic evidence, or if they can be classified as having DM without the 75 g OGTT. The CJD guidelines state that individuals with FPG levels <5.6 mmol/L (100 mg/dL) and/or A1C levels <5.5% are not recommended to have an OGTT. We screened for both FBG and A1C in this study, thus participants had to be below both thresholds to be excluded from a subsequent oral glucose test recommendation. Individuals with FPG of 5.6–6.0 mmol/L (100–109 mg/dL) and/or A1C levels between 5.5–5.9%, are recommended to take an OGTT if they possess one of the multiple risk factors listed in the guidelines, which includes factors such as a first-degree relative with DM, a history of prediabetes, or presence of end organ damage. An additional listed risk factor includes any individuals who are members of a "high-risk population." Since individuals with SCI are at a higher risk for developing DM,[12] any individual that had FBG and/or A1C levels that fell within this range (FPG of 5.6–6.0 mmol/L (100–109 mg/dL) and/or A1C levels between 5.5–5.9%) were categorized as requiring further diagnostic testing, specifically an OGTT. For individuals who had FPG levels between 6.1–6.9 mmmol/L (110–124 mg/dL) and/or A1C between 6.0–6.4%, an OGTT is recommended without the need for evaluating risk factors. Therefore, any individuals in this cohort with FPG values between 5.6 and 6.9 mmol/L (100–124 mg/dL) and/or A1C levels between 5.5–6.4% were categorized as requiring further diagnostic testing via an OGTT. The last group of individuals were those whom were classified as meeting diagnostic criteria for DM due to having FPG levels ≥7.0 mmol/L (125 mg/dL) and/or A1C ≥6.5%, as per the CJD guidelines.

Hypertension (HTN)

Lastly, the Canadian Hypertension Education Program (CHEP) 2012 guidelines for the diagnosis of HTN, recommend that if individuals have an SBP ≥140 mmHg and/or DBP ≥90 mmHg, then they should be further assessed by a physician to specifically examine for the presence or absence of HTN.[18]

Statistical analysis

Statistical analyses were performed using SPSS software (version 20.0; IBM Corporation, Armonk, NY, USA). Continuous valuables are reported as the mean and standard deviation (SD) if normally distributed or the median and inter-quartile range (IQR) if not normally distributed. Categorical variables were reported as the number and percentage. A *t*-test was used to compare between cohort members with tetraplegia (TETRA) and paraplegia (PARA), where variables were normally distributed, a Mann-Whitney *U* test was used to test for differences. If the data distribution were not normally distributed, Fisher's exact test was used to compare the TETRA and PARA groups for categorical variables.

Results

The demographic, impairment and clinical characteristics of the study participants (n = 91) are shown in Tables 1 and 2. In general, the cohort was comprised of middle-aged, wheelchair-dependent men with motor

Table 1 Demographic and impairment characteristics of study participants.

Variable	PARA (N = 49)	TETRA (N = 42)	TOTAL (N = 91)	
Sex (n, %Men)	33 (67.3)	35 (83.3)	68 (74.7)	
Autonomic impairment scale (n, %A and B)	34 (69.4)	23 (54.8)	57 (62.6)	
Current smokers (n, %)	14 (28.6)	8 (19.0)	22 (24.2)	
Duration of injury (yr)	14.0 (6.0–23.0)	15.0 (5.0–26.5)	14.0 (6.0–24.0)	
Age at injury	27.0 (21.0–39.0)	30.5 (20.0–48.3)	27.0 (20.0–41.0)	
Age (yr)	46.8 ± 13.1	50.5 ± 14.2	48.4 ± 13.6	
Height (cm)	173.2 ± 10.0	175.0 ± 10.2	174.1 ± 10.1	
Weight (kg)	76.7 ± 16.3	85.0 ± 20.1	80.6 ± 18.6	*
Body mass index (kg/m2)	25.3 ± 4.3	27.7 ± 5.9	26.4 ± 5.2	*
Waist circumference (cm)	92.5 ± 13.9	98.8 ± 13.9	95.4 ± 14.2	*

Mean ± SD; Median (Interquartile Range).
*P < 0.05 PARA vs. TETRA.

Table 2 Clinical assessments.

Variable	PARA (N = 49)	TETRA (N = 42)	TOTAL (N = 91)
Systolic blood pressure (mmHg)*	123.8 ± 17.7	119.4 ± 19.5	121.8 ± 18.6
Diastolic blood pressure (mmHg)*	79.0 ± 11.0	76.9 ± 12.7	78.0 ± 11.8
Glycated hemoglobin levels (A1C)	0.055% (0.051–0.058)	0.055% (0.053–0.058)	0.055% (0.053–0.058)
Fasting plasma glucose (mmol/L)	5.0 (4.6–5.3)	5.0 (4.7–5.2)	5.0 (4.6–5.3)
Total cholesterol (mmol/L)	4.6 ± 1.1	4.7 ± 1.0	4.6 ± 1.0
High-density lipoprotein (mmol/L)	1.2 (1.1–1.4)	1.1 (1.0–1.4)	1.2 (0.8–1.4)
Low-density lipoprotein (mmol/L)	2.8 ± 0.8	2.8 ± 0.8	2.8 ± 0.8
Triglycerides (mmol/L)	1.1 (0.7–1.8)	1.2 (0.9–2.0)	1.1 (0.7–1.9)

Mean ± SD; Median (interquartile range).
*Mean resting supine blood pressure.

complete SCI of approximately 20 years duration. Body weight, body mass index and waist circumference in the TETRA group were significantly higher than in the PARA group, and were the only variables found to be significantly different between these two impairment groups.

Dyslipidemia (DYS)

Of the 81 participants that had serum screening, 13 (16.0%) reported having been prescribed statin therapy for DYS during the study period (Table 3). The remaining 68 (82.9%) participants who did not report taking statin therapy were categorized into three risk groups based on the CCS Dyslipidemia Guidelines from 2013.[17] Fifty (61.7%) participants were in the Low Risk group, and one of 50 participants in this group met the recommendations for initiating statin therapy. Twelve (14.8%) individuals were in the Intermediate Risk group and four of these 12 individuals met the recommendations for initiation of statin therapy. Five (7.4%) participants were in the High Risk group, which means that all of these participants met the recommendations to initiate statin therapy. Thus, of the 68 participants who were not taking any form of statin therapy, 10 (14.7%) participants met the CCS guidelines for requiring statin medication. In total, there were 23 (28.4%) individuals characterized as having DYS, including participants who routinely reported taking statin medication and those who did not.

Type II diabetes mellitus (DM)

Of the 81 participants, five (6.1%) individuals reported undergoing treatment for DM during the study period, and 76 (93.8%) individuals were not taking any

Table 3 Prevalence of dyslipidemia (DYS), hypertension (HTN) and type II diabetes mellitus (DM) with corresponding therapy profiles.

Dyslipidemia	n (% total cohort, n = 81)
DYS + statin therapy	13 (16.0)
No statin therapy	68 (82.9)
Non-DYS: No statin therapy recommended	58 (71.6)
DYS: Statin therapy recommended	10 (12.3)
Total DYS[a]	23 (28.4)
Type II diabetes mellitus	**n (% total cohort, n = 81)**
DM + DM therapy	5 (6.2)
No DM therapy	76 (93.8)
No DM therapy recommended	30 (37.0)
75 g oral glucose tolerance test (OGTT) recommended	44 (54.3)
Diabetic	2 (2.5)
Total DM or OGTT[b]	51 (63.0)
Hypertension	**n (% total cohort, n = 91)**
HTN medication	13 (14.3)
No HTN medication	78 (85.7)
Below risk thresholds (SBP <140 mmHg and/or DBP <90 mmHg)	65 (71.4)
Above risk thresholds (SBP ≥140 mmHg and/or DBP ≥90 mmHg)	13 (14.3)
Total HTN or abnormal BP[c]	26 (28.6)

[a]DYS based on previous clinical diagnosis or if participants met Canadian Cardiovascular Society (CCS) 2013 Dyslipidemia guidelines for initiation of statin therapy.
[b]Based on prior clinical diagnosis of DM, or having met Canadian Journal of Diabetes guidelines for DM and/or further diagnostic testing via an OGTT.
[c]Based on prior clinical diagnosis of HTN or having met the Canadian Hypertension Education Program guidelines to be further examined for HTN.

medication to control blood glucose (Table 3). Of the 76 individuals not reporting prior prescription of medication to regulate blood glucose, 30 (37.0%) were found to be below both the FPG and A1C thresholds, thus not requiring further diagnostic testing, nor were they classified as diabetic. In contrast, 44 (54.3%) participants had FPG values between 5.6 and 6.9 mmol/L (100–124 mg/dL) and/or A1C levels between 5.5–6.4% and therefore were categorized as requiring an OGTT. The remaining individuals were classified as having DM (FPG levels ≥7.0 mmol/L (125 mg/dL) and/or A1C ≥6.5%), and two (2.5%) participants met these criteria. Thus, of the 76 participants who did not report taking medication for blood glucose regulation, 46 (60.5%) participants met the recommendation for further investigation (i.e. OGTT) (n = 44) or met diagnostic criteria for DM (n = 2). In total, 51 (63.0%) participants had DM, or required an OGTT, including participants prescribed medication and those reporting no prescription of DM therapy.

Hypertension (HTN)

Ninety-one participants had their mean SBP and DBP values recorded. Of these 91 participants, 13 (14.3%) individuals reported taking anti-hypertensive medications and 78 (85.7%) did not (Table 3). Of these 78 individuals not taking anti-hypertensive medication, 13 (16.7%) individuals met the CHEP thresholds of SBP ≥140 mmHg and/or DBP ≥90 mmHg to be further examined by a physician for the presence or absence of hypertension. In total, 26 (28.6%) participants were diagnosed as having HTN or met diagnostic criteria to be further assessed for HTN, including participants with or without anti-hypertensive medication.

Overall, for DYS 43.5% of individuals requiring statin therapy were not taking statin medication, for HTN 50% of individuals with SBP ≥140 mmHg and/or DBP ≥90 were not taking anti-hypertensive medication, and 28.6% of individuals classified as having DM were not taking medication to regulate their blood glucose. In total, 23 (28.4%) of the participants in this study had at least one CVD risk factor that was untreated and three (3.7%) participants had two untreated risk factors. No participants had all three untreated risk factors (DYS, HTN, DM) as only two individuals met the diagnostic criteria for DM.

Discussion

In this study, specific criteria for the diagnosis of DYS, HTN and DM were examined and correlated with self-reported health status and medication profiles in order to determine the frequency of individuals who were not receiving appropriate therapy based on current Canadian guidelines.[16–18] We found that not only is the prevalence of CVD risk factors high, but there is also poor adherence to the guidelines for initiation of treatment for DYS, HTN and DM. The prevalence of these disorders in our cohort is similar to those reported in previous large SCI cohort studies.[19] When comparing the observed prevalence of CVD risk factors to the data reported by Jensen *et al.*, which examined the frequency of secondary health conditions in the SCI population via a large-scale review of the literature, we find our results to be within their reported frequency ranges.[19] Jensen *et al.* reported a prevalence of HTN of 6–25% and a prevalence of diabetes of 5–22%.[19] In this study, we report that 14.3% of our population has been clinically diagnosed with HTN and 8.6% of our population has either been clinically diagnosed with DM or met the diagnostic criteria for DM. While the prevalence of DYS is harder to determine, as the threshold values for diagnosis vary depending on which guidelines are applied, when comparing the frequency of individuals who met thresholds for LDL-C, HDL-C and TG in this study, our results are comparable to previously reported values.[4,8]

Looking next at guideline adherence results for DYS, 23 (28.4%) participants were either taking statin therapy or met the CCS thresholds to be recommended for statin therapy.[16] Ten (43.5%) of these 23 participants were not taking any form of statin or cholesterol medication. It is unclear as to why a large percentage of participants were not taking medication despite being above recommended risk thresholds, as there are few studies that have yet to examine this correlation in the SCI population.[20] This same issue is apparent when comparing recommendations for HTN (based on CHEP guidelines) and DM (based on CJD guidelines) to the percentage of individuals receiving treatment. Twenty-six participants (28.6%) were either previously diagnosed as having HTN or met the CHEP threshold for possible HTN, and 13 (50.0%) of these individuals were not taking any antihypertensive medication. While the guidelines do not state that meeting the cutoff of SBP ≥140 mmHg and/or DBP ≥90 mmHg requires immediate antihypertensive treatment, it is recommended that individuals meeting this cutoff be assessed by a physician who is required to take three SBP and DBP measurements and use the average of the final two measurements to assess for HTN.[18] As the values reported in this study were an average of four measurements, we are confident that they are an accurate reflection of the average SBP and DBP. The guidelines then further state that if the patient has

macrovascular damage, DM or chronic kidney disease, or if upon averaging SBP and DBP over five visits with an office blood pressure monitor (OBPM) the SBP $\geq$140 mmHg and/or DBP $\geq$90 mmHg, then the patient can be diagnosed as being hypertensive and should be prescribed antihypertensive medication.[18] While these criteria may change the number of participants who meet criteria for treatment, we anticipate that the prevalence of abnormal BP in our sample would not change significantly considering the additional diagnostic criteria. Thus, there is a relatively large proportion of individuals who are likely to be hypertensive, yet are not receiving any antihypertensive medication.

The proportion of individuals who were either clinically diagnosed as having DM or met the CJD guidelines for diagnosis of DM was relatively small as only seven (8.6%) participants met the specified criteria.[17] Five of these seven individuals were taking medication for DM, while two were not. While the small number of individuals with DM limited our interpretation of the results, it is still evident that a proportion of the population that should be on medication for DM is not. This becomes even more apparent when looking at the proportion of individuals who were recommended for further diagnostic testing. A total of 44 (57.9%) of the 76 individuals who were not taking any medication for DM, met the CJD recommendation for administration of an OGTT in order to further screen for DM.[17] In a study conducted by Bauman *et al.* (1999), 201 adults with SCI were administered a 75 g OGTT and 13.4% were classified as having DM (based on the same cutoffs recommended by the CJD) while 27.8% were characterized as having impaired fasting glucose (IFG), which the CJD guidelines outline as being a diagnosis of prediabetes.[21] According to the CJD, individuals diagnosed with prediabetes are at a high risk of developing DM as well as CVD and must be screened regularly along with implementing lifestyle changes and developing strategies that reduce CVD risk factors.[17] If we apply the observed percentages of DM from Bauman *et al.*'s study to the proportion of our study participants who were recommended for an OGTT, then approximately six more individuals would be classified as having DM, leading to a total of 13 individuals with DM, and 12 individuals would be diagnosed as prediabetic. Thus, there is a high likelihood that there are individuals with undiagnosed and untreated diabetics and pre-diabetics within our OGTT-recommended group.[21]

When examining our study population for CVD risk factors leading to DYS, HTN and DM, it can be seen that there are a significant proportion of individuals for each disorder that are not being treated based on current guidelines. This highlights an important issue, in that there is insufficient emphasis in the SCI community to screen patients regularly for these disorders, especially considering that they are at a high risk for all three.[10,12,14] This may be due to a lack of specific recommendations in place for patients with SCI that outline the frequency to which they should be screened. Since current guidelines are based on able-bodied individuals, they do not consider the highly elevated risk that individuals with SCI have of developing CVD risk factors, and thus the recommendations made by these guidelines with respect to both the age and the frequency to which individuals should be screened, may not be appropriate for the SCI population. This issue may also be leading to patients with SCI underestimating the importance of implementing strategies to reduce CVD risk factors, as a lack of screening protocols specifically tailored to this population may be resulting in reduced emphasis to screen and treat these patients regularly. In addition, there may be insufficient programs in place to assist this population in adhering to lipid-lowering therapies. Vegter *et al.* demonstrated that patients are significantly more likely to adhere to lipid-lowering therapies if pharmaceutical intervention programs are in place within the community.[22] Intervention programs that assist this vulnerable population in adhering to lipid-lowering therapies may help patients with SCI become more aware of their elevated risk of developing CVD and may lower the prevalence of CVD risk factors in this patient population. Furthermore, reduced accessibility to primary care, and heightened financial or logistical constraints in the SCI population are potential contributing factors worthy of consideration.[23,24]

Comparing the frequency of participants with untreated risk factors in this study to the general population, it is clear that rates observed in the SCI population are higher. A study conducted by Furthauer *et al.* found that in 501 able-bodied individuals, there was a 16.8% rate of non-adherence to guideline recommendations for quality indicators of DM, HTN, CVD, heart failure and atrial fibrillation.[25] It was found that 61.5% of these cases of non-adherence were caused by errors in the judgment of physicians in accurately diagnosing patients according to treatment recommendations.[25] This error in judgment may be contributing to the observed low adherence rates in the SCI population as well, however this is unlikely the sole factor involved, as it cannot account for the significantly higher rates of non-adherence observed in this

study (43.5% for DYS, 50.0% for HTN and 28.6% for DM). Other cross-sectional studies examining adherence to guidelines for quality indicators of cardiovascular care in the general population have also demonstrated higher rates of adherence than those reported in this study.[26–29] Liddy *et al.* reported that from 194 primary care physicians in Ontario, Canada, adherence to guideline rates were over 75% for coronary artery disease, HTN and DYS, with adherence rates to screening protocols for measurement of lipid profile for DYS, blood pressure for HTN and fasting blood glucose for coronary artery disease of 82.8%, 79.4% and 80.0% respectively.[26,27] This data suggests that there are factors specific to the SCI population that are contributing to the lower observed rates of guideline adherence than the general population, such as poor access to primary care office settings, limited family physician awareness of the elevated CVD risk, infrequent participation in general health screening due to competing medical priorities, over reliance on Framingham risk calculator by physicians due to the lack of SCI-specific treatment guidelines and screening protocols, and insufficient resources for purchasing prescribed medications.[23,24]

We recommend that SCI-specific guidelines be developed and implemented to ensure early screening and more frequent diagnosis of these disorders, as there is a clear disconnect between having screening guidelines in place versus implementing them in this vulnerable population. This is an important issue that requires consideration when physicians are implementing current guidelines in the SCI population. Recent efforts in Canada to address this dilemma have included the development and dissemination of Actionable Nuggets for special populations of low prevalence.[30] Actionable Nuggets are brief, focused communications about the primary care needs of special populations in primary care. A knowledge translation effort of this nature paired with SCI-specific guidelines has the potential to transform care.

Additionally, the observed low treatment rates in this study may imply that cardiovascular health is not the primary health concern for individuals with SCI, as they tend to have multiple morbidities and many competing health issues to address at the same time.[31] Anderson *et al.* demonstrated that patients with SCI primarily focus on therapies that pertain to their hand and leg function, bowel and bladder function, and other non-CVD related health concerns.[32] This may be a legitimate factor that is leading to their inappropriate CVD screening rate.

This study has certain limitations that must be considered when interpreting our data. Firstly, the SBP and DBP measurements were all taken in one day, which may not accurately represent the true average, as BP tends to fluctuate daily, especially in individuals with SCI.[33] Thus, the recommendations made based on these measurements may underestimate or overestimate the prevalence of HTN in some individuals. Secondly, since the guidelines applied to this population are derived from data regarding risk and disease expression in able-bodied individuals, the recommendations may not adequately represent the SCI-specific population risks and thus recommendations for both the age and the frequency of screening are likely to underestimate the prevalence of these conditions amongst individuals with SCI. In addition, the relatively small sample size in this study (n = 91), has resulted in a very limited number of individuals being characterized as having DM, thus our reported percentages of participants not taking medication may not be representative of a larger population. Furthermore, the medication profiles were self-reported and therefore may reflect adherence to therapy more than screening rates or physician prescription patterns. Nonetheless, our self-reported rates of CVD risk factors are similar to rates reported in previous self-reported national health surveys conducted in individuals with SCI, thus we are confident that the results we have reported are within the expected rates typically observed in SCI populations.[12,20]

Conclusion

This study demonstrates that many individuals with chronic SCI affiliated with a tertiary spinal cord rehabilitation center are not only presenting with multiple CVD risk factors such as HTN, DYS and DM, but also may not be being screened or adequately treated for these risk factors, as is suggested by the observed insufficient adherence to established Canadian HTN, DYS and DM treatment guidelines. This data highlights the need for targeted knowledge translation activities to address the gaps between the observed prevalence of disease, presumed low rates of screening and poor guideline adherence. This is vitally important given that CVD is amongst the leading causes of mortality in the SCI population.

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Conflicts of interest None.

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